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International Technological Diffusion Channels, and Technology Policies in Turkey

Bahar Şanlı[a]*, Elif Haykır Hobikoğlu[a]

Istanbul University, Faculty of Economics, Beyazıt, Istanbul 34452, Turkey

Abstract

The usage of technological diffusion mechanisms is among the methods of developing countries to use and adapt new technologies. The mechanism of technological diffusion is the integration of worldwide technology accumulation to countries by numerous tools and methods.
Technology policies are crucial for determining the speed, direction and route of technological development. It is of great importance by means of effective economy policies, to determine technology policies, which lets technology production and targets knowledge accumulation and qualified workforce.
At this point, it is a must, to increase scientific effectiveness, to maintain university-industry cooperation, to support educational policies with technological development, to determine technology transfer policies, to maintain continuation and increase effectiveness of resources allocated to R&D expenses, to increase the number of patents received on behalf of the country, and to adapt all these to the policy.

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Keywords: International Technological Diffusion; Technology Policies; Turkey

1. Introduction

In 1990's when technological developments accelerated, importance given by economists to technological innovations and technological development started to increase. While competitive power gained by countries which use advanced technology in the world markets directs particularly developed countries to R&D activities and production of new technology; it directs the developing countries which cannot provide technological development

* Corresponding author: Tel.: +90-532-295-8524; fax: +90-212-262-2448.
E-mail address: bsanli@istanbul.edu.tr

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with their own knowledge accumulation to transfer of advanced technology. Production of new technologies and providing technological diffusion by transferring of knowledge accumulation formed in this process to internal and external markets play an important role particularly for developing countries to reach the level of developed countries and thus, it is of importance in terms of use of new technologies and diffusion of innovations among the developed countries. The ability of countries of complying with global competition conditions, high economic growth rate and the ability of gaining technological progress level are closely related with technology policies of these countries. On the other hand, economy policies to be established by taking development level and technological needs into consideration have also an effective role in success of technology policies. While science and technological developments are globalizing in this globalized world; the target of Turkey in this order is to integrate with the world, to reach the level of developed countries, by the help of precautions like establishing national innovation system, regulating technology policies, developing advanced technologies, in order to reach high growth rate and gain competitive power in international markets.

2. Technological Diffusion and Diffusion Channels

Technological diffusion can be defined as production of new technologies through R&D activities and transfer of knowledge accumulation provided in this process inside the country and abroad over various channels (Coe and Helpman, 1995). In a simpler expression, technological diffusion having great importance for national economies is "transfer of processed information from one group to another" (Kiper, 2004). On the other hand, technological diffusion is of importance in terms of using new technologies for the developed countries and diffusion of innovations among the developed countries (Keller, 2004). New technologies and innovative production generally reach to other countries by means of technological diffusion as a result of economic activities. Outwardness of countries may be effective in gaining favor from technological diffusion (Coe and Helpman, 1995). Technological diffusion can also occur via different channels. From this viewpoint, it occurs with diffusion of technological innovations domestically, domestic R&D activities and overflow effects of these activities. While R&D activities are effective in innovation invention of firms, adaptation of this innovation to another firm or sector provides diffusion of new technologies domestically by means of overflow (World Bank, 2008) and increase of productivity. Only effects of domestic R&D activities had been taken into account until 1990's in the technological diffusion; however, importance of foreign R&D activities was realized when globalization gained speed and economic and social liberalization among countries started. Foreign R&D activities can diffuse to other countries by showing overflow effect via direct foreign capital investments and economic relations (Coe and Helpman, 1995). Technological diffusion is highly important for the developing countries which cannot finance particularly costly R&D activities to utilize from the innovations. Direct foreign investments generally realized by multi-national countries both create productivity increase and diffusion of new technologies to the country by providing technology transfer to the country where investment is done (Sever et al., 2010). Direct foreign investments which are extremely effective as technological diffusion channels contribute to particularly developing countries for raising technological development level via increase in labor quality, transfer of new technology to the country and diffusion of new information (Lenger and Taymaz, 2006). Another diffusion channel of innovations/new technologies invented by particularly developed countries to other countries is import made from these countries. The more a country is outward-oriented, the more productivity increase provided by foreign trade is (Coe and Helpman, 1995). In the foreign trade made with countries having advanced technology, intermediate goods and capital goods imported from these countries which contain advanced technology intensively provide transfer of technological knowledge accumulation of developed country to the developing country (Keller, 2002). Another channel of technology diffusion is international patents' rights. The aim for granting patent right is to obtain advanced technology by way of paying usage charge of innovation invented. Technological diffusion is provided in such way (Rockett, 2010). Importer country should absorb the technology in order to gain favor from innovation/new technologies transferred among countries by way of technological diffusion and to realize the technological development. The most important element for particularly developing countries to reach the level of developed countries is the absorption of advanced technologies transferred (Kök and Şimşek). Absorbing the advanced technologies by any country by way of transfer of technology transfer and using them effectively are only possible with qualified human capital. Well-

educated and qualified labor (Keller, 2004) contributes into the increase of productivity. Apart from human capital, conformity of technology to be transferred to the economic structure of the country is effective in absorption of innovations and technological progress of countries (Ansal, 2004). Technological diffusion realized from developed countries causes changes in social structure and value judgments of countries transferring technology. In this respect, selection of appropriate technologies is highly important (Ansal, 2004).

3. Literature Review

Some of studies in regard to international technological diffusion are given in the following table.

Author	Year	Contribution
Schumpeter	1942	Innovation and advanced technologies are driving force of social and economic development and growth
Nelson and Phelps	1966	Role of human capital of the country in absorption of technology transferred from foreign countries
Findlay	1978	Effect of direct foreign capital on technological development and technological diffusion in the country where the investment is made
Porter	1991	Importance of development created in product technology with technological innovations in gaining international competitive power
Jaffe, Trajtenberg and Henderson	1993	Importance of patents in providing transfer of technological knowledge
Benhabib and Spiegel	1994	Effect of human capital on increasing capacity of the country by making technological innovation and productivity
Coe and Helpman	1995	Positive effects of openness in the economy on technological diffusion
Eaton and Kortum	1996	Role of patent rights in technological diffusion
Borensztein, de Grogorio and Lee	1998	Effect of new knowledge, advanced technology and qualified human capital transfer with direct foreign capital investments on technological development level
Hakura and Jaumotte	1999	Determination of effect of intra-industry and inter-industry trade and intra-industry trade on technological transfer as technological diffusion channels
Oliner and Sichel	2000	Effect of fast diffusion in the information technology on the economic growth
Laporte	2002	Importance of national technology policies in absorption of new technologies
Keller	2004	Contribution of international technological diffusion into diffusion channels and developing and developed countries
Shih and Chang	2009	Classification and types of diffusion channels in technological diffusion
Keller	2010	Effect of international trade and direct foreign capital investments on technological diffusion and contributions provided for the countries
Rockett	2010	Patents having an important place in diffusion of innovation information

4. Technological Policies in the World

Technological progresses bring about change in competition structure and markets (Zerenler et al., 2014). Technology policies to be determined by countries in regard to having new technologies and to implement these technologies within the scope of gaining international competitive power and economic development are of great importance. Functionality of technology policies determined depends on determination of policies allowing new technology production and targeting to reach knowledge accumulation and qualified human capital. Technology policies can be defined as decisions taken by governments for the purpose of affecting rate and direction of technological development and practices of governments (Taymaz, 2001). According to another definition, technology policy is to develop and direct scientific and technological activities in such way which will take requirements of any country in economic, social, political and military fields and their future targets into account

(Çiftçi, 2014). The basic aim of technology policies, whose importance has been increasing since the mid of 1990's when particularly globalization and technological developments gained speed in the world, is to gain high technological progress level and thus, it is accepted as creating social welfare increase (Steinmueller, 2010).

Also, the following issues are among the objectives of technology policies (Taymaz, 2001):

- Building necessary infrastructure for sustainability of innovations and realizing cooperation among establishments included into this system
- Developing corporate structure by establishing brigade establishments and increasing the efficiency of national innovation system
- Providing sustainability of knowledge accumulation by way of establishing non-market mechanisms and network organizations
- Raising absorption capacities of firms needed for realizing innovations by providing financial support and taking measures intended for development of innovation culture.

Means used for achieving the objectives of technology policies may be classified under the headings of R&D activities, intellectual property rights and risk capital. While R&D activities of technology policy means increase technological knowledge accumulation of firms in terms of private sector, it raises capacities of making innovation in long-term (Audretsch et al., 2002). R&D activities conducted by public sector are intended for creating infrastructure particularly in this field and making basic non-profit researches for the firms. Countries also support the specific R&D activities for the purpose of promoting private sector in addition of R&D activities conducted by public institutions (Taymaz, 2001). An effective technology policy means used for protection of innovations is intellectual property rights. Legal arrangements in intellectual property rights are intended for prohibition of use, export or import of innovation invented by manufacturer for a given period (Maskus 2004). Legal arrangements covering protection of patents, copyrights, trademarks, industrial designs and trade secrets, etc may vary from country to country (Candelin-Palmqvist et al., 2012). This provisional monopoly right provided for inventor is of importance in terms of providing increase in social welfare and innovation incentive (Leger, 2005). Another means of technology policies is risk capital. Countries can make risk capital an important means of technology policies by giving incentives intended for increasing number of risk capital companies providing fund for innovation activities (Hall and Lerner, 2010). While risk capital companies may give the funds to be given to the firms in form of research grant, investment credit, purchase of shares (Carlsson and Jacobsson, 1997), they may give in form of supporting management of firms established recently (Guerrieri and Tylecote, 1997).

5. Technology Policies in Turkey

Determination of technology policies targeting innovative/new technology production in reaching conformity with global competition conditions and economic growth rate targeted is of great importance (Çiftçi, 2014). Turkey put report titled "Vision 2023: Science and Technology Strategies" prepared by TÜBİTAK in 2001 in line with these objectives into practice. The report which is of great importance in terms of establishment of national innovation system and development of technology policies contains the numerical objectives in line with development of strategic technologies, increasing R&D activities, growing qualified human capital and thus, gaining global competition power (TÜBİTAK, 2004). On the other hand, when technology policy objectives of Turkey in 2000's are examined within the framework of Development Plans; the basic aim in 8th Five Years of Development Plan containing 2001-2005 is determined as gaining international competition power by increasing scientific and technological developments, enhancing the country's level of scientific and technological research by developing necessary physical, human and legal infrastructure in the international competition, revising the education policies for the purpose of creating human capital which will comply with ever-changing new technologies and establishing cooperation among university, public and private sector (DPT, 2004). The Ninth Development Plan has been prepared within the framework of vision of "Turkey growing within stability, sharing its income more fairly, having competitive power in global scale, transforming into knowledge society, having completed its harmonization process of EU membership" and Long-term Strategy (2001-2023). The aim of the plan is to increase the skill of

private sector for creating innovation regards the innovativeness as an important element in gaining international competitive power (DPT, 2006). From this point of view, implementing policies intended for increasing technology and innovation capacity (Republic of Turkey, Ministry of Development, 2013) has been one of the most important objectives during the period. Continuing the cooperation between university and public sector increasingly in R&D activities, creating qualified human capital which is able to use new technologies, increasing and generalizing the efficiency of technology policy means such as risk capital as is in 8th Plan, strengthening the cooperation between institutions and organizations included into national innovation system, establishing Technology Development Regions bringing universities and private sector together, establishing Technology Transfer Centers which will serve in putting new knowledge obtained with R&D activities into practice and providing cooperation in obtaining innovations/new technologies with transfer of information and technology among countries are among the objectives of plan (DPT, 2006). In the 10th Development Plan prepared for the years of 2014-2018, the aim may be summarized as increasing the role of private sector in development of R&D activities and new technologies and gaining competitive power in foreign markets by creating an economical structure based on innovation and advanced technology (Republic of Turkey, Ministry of Development, 2013).

6. Basic Technological Indicators in Turkey and Developing European Countries within the Framework of Technological Diffusion

Welfare differences between developed and developing countries are mainly resulted from differences in technological development of countries. The developing countries have not technological knowledge accumulation and qualified labor. From this point of view, they are able to reach new technologies only by using technological diffusion channels. For Turkey, being close to the developed European countries whose the skill of producing innovation/new technology is high is an advantage in terms of providing innovations/new technologies by using technological diffusion channels. In this context, we are informed about success of technology policies implemented by Turkey by comparing the statistical data belonging to the developing European countries and Turkey.

Table 1: Share of R&D Expenses within GDP (%)

	2000	2005	2006	2007	2008	2009	2010	2011	2012
Bulgaria	0,51	0,46	0,46	0,45	0,47	0,53	0,60	0,57	0,64
Czech Republic	1,17	1,22	1,29	1,37	1,30	1,35	1,40	1,64	1,88
Estonia	0,60	0,93	1,13	1,08	1,28	1,41	1,62	2,37	2,18
Hungary	0,81	0,94	1,01	0,98	1,00	1,17	1,17	1,22	1,30
Latvia	0,44	0,56	0,70	0,59	0,61	0,46	0,60	0,70	0,66
Lithuania	0,59	0,75	0,79	0,81	0,80	0,84	0,80	0,92	0,90
Poland	0,64	0,57	0,56	0,57	0,60	0,67	0,74	0,76	0,90
Romania	0,37	0,41	0,45	0,53	0,58	0,47	0,46	0,48	0,49
Slovenia	1,38	1,44	1,56	1,45	1,65	1,86	2,11	2,47	2,80
Turkey	0,48	0,59	0,58	0,72	0,73	0,85	0,84	0,86	0,87
Slovakia	0,65	0,51	0,49	0,46	0,47	0,48	0,63	0,68	0,82
EU	1,80	1,82	1,84	1,84	1,94	2,04	2,03	2,04	2,06

Source: World Bank, http://www.data.worldbank.org

When share of R&D expenses within GDP is examined in terms of developing European countries and Turkey, it is seen that Slovenia and Czech Republic are the closest countries to EU average. It can be said that the said country group increased R&D expenses in the given period however this increase was inadequate in terms of technological development.

Table 2: Number of Researcher working in R&D Units (in one million people)

	2000	2005	2006	2007	2008	2009	2010	2011	2012
Bulgaria	1185	1308	1356	1481	1517	1607	1486	1623	1552
Estonia	1952	2514	2664	2810	3043	3311	3140	3485	3541
Lithuania	2223	2324	2464	2654	2683	2737	2802	2756	2650
Poland	1439	1627	1560	1608	1618	1600	1689	1679	1754
Turkey	365	578	622	715	751	811	892	987	989
EU average	2261	2772	2858	2921	3063	3125	3211	3224	3156

Source: World Bank, http://www.data.worldbank.org

While the closest two countries to EU average by means of the number of researchers working in R&D units are Estonia and Lithuania, it is observed that Turkey is further behind this average.

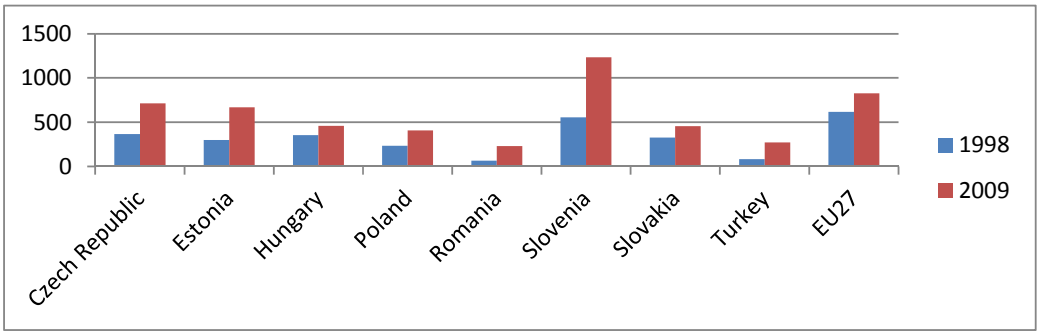

Fig. 1. Number of Scientific Publication per one million of population (Source: OECD, *Science, Technology and Industry Outlook 2010*)

The sole country having the article publication above EU-27 average in the related year within the said country group was Slovenia. Romania and Turkey increased the number of scientific publication by creating a great difference from 1998 to 2008.

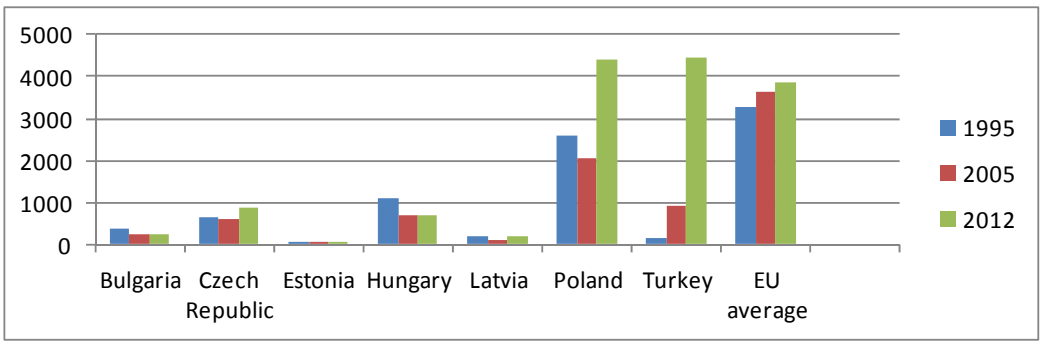

Fig. 2. Number of Patent Application (piece) (permanent residents) (Prepared by utilizing from data of The World Bank)

Since patent applications made and patent numbers taken represent the countries' capacity of making valid innovation in the international platform, they are two of important indicators of technological diffusion.

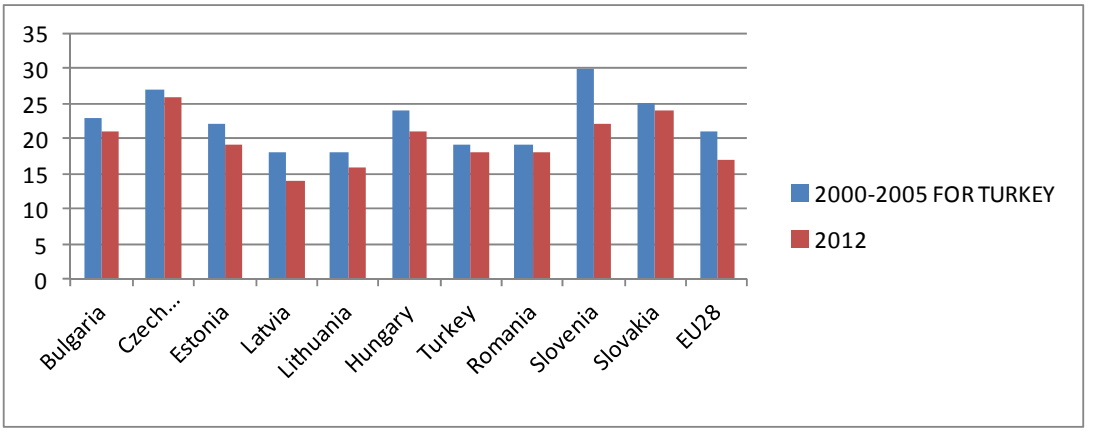

Fig. 3. Share of Manufacturing Industry Labor within Total Labor (%) (Source: EUROSTAT (2014). "European Commission, European Statistics")

When share of manufacturing industry labor within total labor which is one of the indicators of technological diffusion is examined in terms of developing European countries and Turkey, it is seen that this rate decreases in the basis of years. The country experiencing the greatest fall in the period covering 2000-2012 years was Slovenia. Change in this rate in Turkey could be calculated for the period between 2005 and 2012.

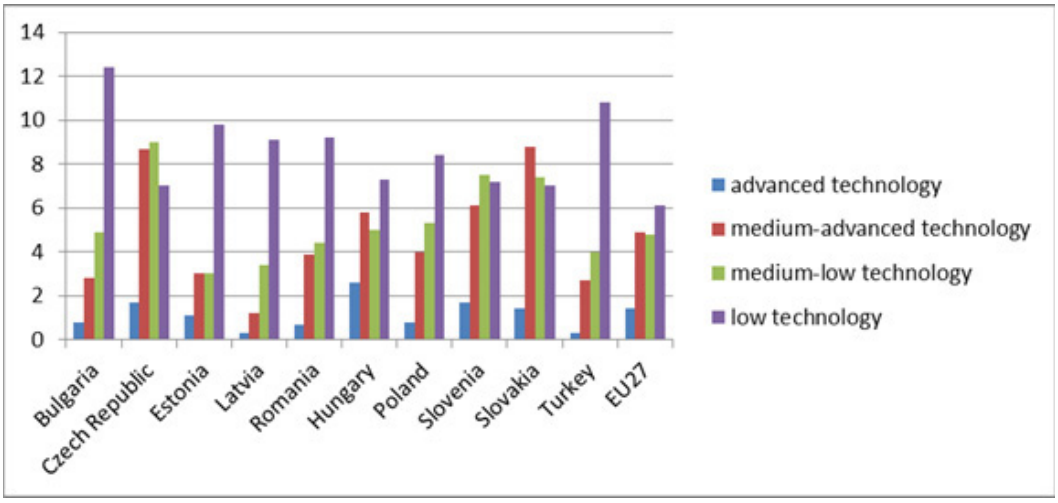

Fig. 4. Share of Manufacturing Industry Labor within Total Labor by Technology Intensity of Sectors (%) (2012) (Source: It was prepared by compiling from data of TUIK and The World Bank)

In the majority of the countries examined, it is seen that labor employed in high-technology sectors is quite lower than EU-27 average; labor in low-technology sectors has quite higher values compared with the average. It is seen that employment in low-technology sectors in Bulgaria, Lithuania and Turkey is at the highest level.

Table 3: Share of High-technology Product Manufacturing within Finished Products' Export (%)

	2000	2005	2010	2011	2012
Czech Republic	8.49	12.95	15.30	16.28	16.08
Estonia	29.93	14.66	9.27	13.39	10.74
Hungary	26.53	25.83	24.07	22.73	18.09
Lithuania	4.46	6.15	10.61	10.21	10.42
Latvia	3.96	5.31	7.64	8.24	9.78
Romania	5.87	3.38	10.95	10.18	6.38
Poland	3.36	3.79	6.69	5.87	6.95
Slovenia	4.91	4.93	5.72	5.80	6.18
Slovakia	3.63	7.44	6.77	7.10	9.30
Turkey	4.83	1.47	1.93	1.84	1.83

Source: The World Bank, http://data.worldbank.org/

When Table 3 is examined, it is seen that Turkey's export of high-technology product is lower than the developing European countries and this rate decreases by the years. It is seen that countries' high-technology product exports, apart from Estonia and Hungary, follow an increasing course by the years, but this change in Estonia and Hungary is at the decreasing course. The said countries have low high-technology product exports and this shows that such countries should implement technology policies intended for using technological diffusion channels.

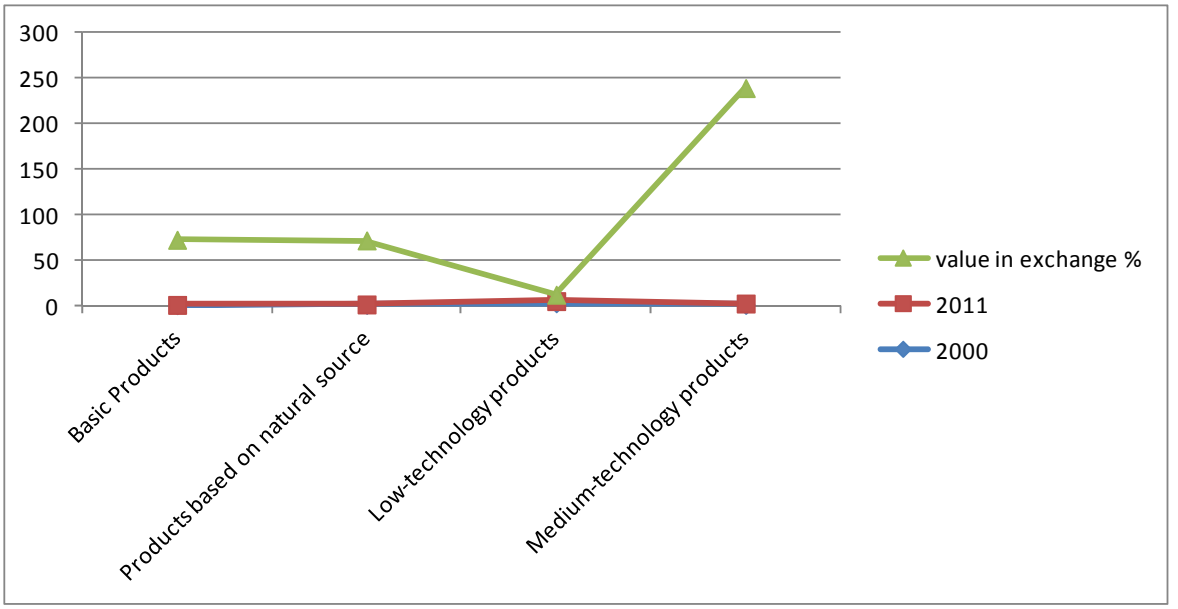

Fig. 5. Market Shares of Turkish Industry in EU-15 Market (Source: Comtrade, TEPAV)

When share of Turkish Industry in EU15 market is examined, it is seen that change level in the recent 10 years of process has the highest rate as percentage in medium technology products.

7. Conclusion

Gaining speed of technological development and technological diffusion is closely associated with national, industrial and regional innovations. Policies to be implemented in line, in countries targeting technological development, may be listed as strengthening R&D activities which can create new sector, product and brands that may be competitive and high added value in international markets, allowing Technology Development Regions to work more effectively, increasing R&D activities by providing incentives increasing cooperation between university-private sector and public-private sector, providing incentives intended for increasing employment of qualified human capital both in public sector and private sector, developing regional and global cooperation, facilitating the technology transfer within this scope and promoting innovative entrepreneurship. In the viewpoint of Turkey, additional to these policies, it is targeted to increase Gross Domestic Product rate of R&D expenses to 1,8% for 2018, domestic patent application number (to Turkish Patent Institute) to 16.000 for again 2018 in patent applications, the number of Turkey-originated international and regional patent application number (international patent application and European patent) to 2.140 and to reach the schooling rate in higher education in terms of success of education policies (excluding Postgraduate education) to 94% level in total in the future forecasting of Republic of Turkey Ministry of Development towards technology policies.R&D investments should be encouraged and sustainability of technology policies by making education investments which will allow development of intellectual capital channels should be provided in order to create effective use area of all means of technological diffusion channels. When statistical data belonging to developing European countries and Turkey that were addressed in the study are examined, lowness of indicators reveals the necessity of determining the use of technological diffusion means and effective technological policies in order to increase technology production capacity in terms of these countries. The number of researcher working in R&D units, the number of scientific publication, patent number, number of manufacturing industry labor within total labor, experiencing increase in basic points such as high-technology product export are of great importance in terms of success of policies to be implemented and more effective use of technological diffusion channels for the developing countries.

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